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(54) PLASTIC MATERIAL DISCRIMINATION APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a material discrimination apparatus by which plastics with a small specific-gravity difference can be sorted and by which the plastics can be sorted without being broken into pieces by a method wherein a material is discrimninated on the basis of the absorbance of a specific wavelength by the plastics.
SOLUTION: In a pretreatment and sorting device 21, caps or the like out of waste plastics are sorted, bottles or trays are pretreated mechanically, and the accuracy of a near-infrared discrimination device 29 on the downstream side is enhanced. In addition,

in the device 29, bottles as samples which are aligned are irradiated with near-infrared rays by a light source 31, a quantity of transmitted light at a wavelength peculiar to the samples by a spectroscope 33 is received by a photodetector 32, the absorbance of every wavelength at every sample is computed, and a material is discriminated. Then, a sorting device 30 with a sorting box 40 sorts and houses various kinds of plastics discriminated by the device 29 by using the high-pressure air from a pulse air nozzle 41.

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CLAIMS

[Claim(s)]

[Claim 1] The quality-of-the-material identification unit of the plastics characterized by to provide the identification unit which has the photo detector which detects the transmitted light or the reflected light of exposure light from said plastics from the pretreatment selector which carries out outline judgment of the plastics, the transport device which the pretreated plastics is aligned and is conveyed, the light source which irradiates a near infrared ray at said plastics, and this light source, and identifies the

quality of the material with the absorbance of the specific wavelength by said plastics, and the judgment equipment which are controlled by this identification unit.

[Claim 2] In case it identifies with said identification unit, the specific wavelength of the transmitted light from said plastics or the reflected light according to one extinction peak which appears in 1660-1669nm at the time of polyethylene terephthalate According to one extinction peak which appears in 1677-1698nm, at the time of polystyrene According to two extinction peaks which appear in 1710-1726nm and 1726-1735nm, at the time of polypropylene According to two extinction peaks which appear in 1716-1729nm and 1746-1754nm, at the time of a polyvinyl chloride It is the quality-of-the-material identification unit of the plastics according to claim 1 characterized by identifying the class of plastics according to one extinction peak which appears in 1710-1735nm at the time of polyethylene.

[Claim 3] The quality-of-the-material identification unit of the plastics according to claim 1 or 2 with which said pretreatment selector is characterized by having the migration equipment and the pulse air nozzle of plastics.

[Claim 4] The quality-of-the-material identification unit of the plastics according to claim 1 to 3 characterized by considering as the configuration which sorts out the plastics which said pretreatment selector ventilated by the fan for wind selections, made move the plastics on an oscillating screen conveyor, and moved by the pulse air jet hole.

[Claim 5] The quality-of-the-material identification unit of the plastics according to claim 3 or 4 characterized by constituting said transport device by two or more conveyors arranged concurrent at the blowdown side of said pulse air jet hole.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to judgment of specific plastics, and the quality-of-the-material identification unit of the plastics applied to recovery about the quality-of-the-material identification unit of plastics from the waste plastic which is the resource contaminant and industrial waste which are discharged from a home.

[0002]

[Description of the Prior Art] Conventionally, about judgment of a waste plastic, separating plastics using the specific gravity difference of plastics using a liquid cyclone is known. Specifically, 98.6% of concentration and polystyrene with specific gravity heavier than lower discharge are obtained [polyethylene (specific gravity 0.93) and polystyrene (specific gravity 1.05)] for polyethylene with specific gravity lighter than

up discharge at 94.7% of concentration. Moreover, in addition to this, wind-force sorting and sinking sorting are similarly performed efficiently as use of a specific gravity difference. Drawing 5 shows an example of the distinction approach of the conventional waste plastic.

[0003] A waste plastic (raw material) 1 is first supplied to a crusher 2. The waste plastic 1 after crushing is sent to a depot 3, and are collected temporarily. Then, a waste plastic 1 is supplied to the churning tank 5 from the weight or volumetric or counting feeder 4 arranged at the lower part side of a depot 3. The water 6 of a constant rate is supplied to this churning tank 5, and it is adjusted to fixed concentration. Next, the mixture of this plastics and water is quantitatively supplied to a liquid cyclone 8 with the centrifugal pump 7 by which the rotational frequency was controlled, low-specific-gravity plastics is discharged from the cyclone upper part to the washing dehydrator 9, water and plastics are separated, and water is filled for low-specific-gravity plastics in the circulating water tub 11 by specific gravity small ** 10. Moreover, it discharges with high-specific-gravity plastics and water from the lower part of a liquid cyclone 8, and with the washing dehydrator 12, water and plastics are separated and water is filled for high-specific-gravity plastics in the circulating water tub 11 by specific gravity large ** 13 temporarily. As a product, specific gravity smallness plastics is taken out for specific gravity base plastics from specific gravity small ** 10 from specific gravity large ** 13 again.

[0004]

[Problem(s) to be Solved by the Invention] However, according to the conventional technique, the following technical problems occurred.

(1) About polyethylene (0.93) and polypropylene (0.90-0.91) with the almost same specific gravity, it is inseparable. Moreover, in the conventional technique, it was difficult to classify plastics without a specific gravity difference (few). Furthermore, unless it grinds, the fluidity within a liquid cyclone is bad and it cannot dissociate [lock out can take place and].

[0005] (2) It is very difficult to align a waste plastic according to a class without lapping at a time on [one] a conveyor when identifying the quality of the material using a near-infrared identification unit.

(3) When it recycles a waste plastic, it is required to divide the identified quality of the material into a high speed.

[0006] This invention aims at offering the quality-of-the-material identification unit of the plastics which can classify plastics even if it does not grind while being made in consideration of such a situation and being able to classify plastics with few specific gravity differences.

[0007]

[Means for Solving the Problem] This invention is the quality-of-the-material identification unit of the plastics characterized by to provide the identification unit

which has the photo detector which detects the transmitted light or the reflected light of exposure light from said plastics from the pretreatment selector which carries out outline judgment of the plastics, the transport device which the pretreated plastics is aligned and is conveyed, the light source which irradiates a near infrared ray at said plastics, and this light source, and identifies the quality of the material with the absorbance of the specific wavelength by said plastics, and the judgment equipment which are controlled by this identification unit.

[0008] In this invention, in case it identifies with said identification unit, the specific wavelength of the transmitted light from said plastics or the reflected light according to one extinction peak which appears in 1660-1669nm at the time of polyethylene terephthalate (PET) According to one extinction peak which appears in 1677-1698nm, at the time of polystyrene (PS) According to two extinction peaks which appear in 1710-1726nm and 1726-1735nm, at the time of polypropylene (PP) The class of plastics is [with two extinction peaks at which it appears in 1716-1729nm and 1746-1754nm at the time of a polyvinyl chloride (PVC)] discriminable with one extinction peak which appears in 1710-1735nm at the time of polyethylene (PE).

[0009]

[Embodiment of the Invention] Hereafter, the quality-of-the-material identification unit of the plastics concerning one example of this invention is explained with reference to drawing 1 and drawing 2 . Drawing 1 is the explanatory view of the pretreatment selector which is one configuration of this identification unit here, and drawing 2 is the explanatory view of the near-infrared type identification unit which is one configuration of this identification unit, and judgment equipment.

[0010] First, the pretreatment selector 21 is explained using drawing 1 . The code number 22 in drawing is a fan for wind selections who distributes the waste plastic (it is hereafter called a plastic waste for short) sent from a raw material plastic waste hopper on the after-mentioned conveyor. The plastic waste which passed the oscillating screen conveyor 23 by said fan 22 for wind selections is divided roughly by two or more pulse air jet holes 24 of 1 constant pressure. that is, the heavy plastic waste of bottle 25 grade -- near (less than 1m) -- until -- **** -- it is not flown but conveyor 26a is reached, and the light plastic waste of tray 27 grade is flown a long distance (1m or more), and reaches conveyor 26b. Moreover, since it is quantitatively few, from on said oscillating screen conveyor 23, it falls and excepts, small plastic waste (accessories of cap 28 grade), for example, following [30mmx30mm]. Thereby, the engine performance of a whole system (pretreatment, discernment, and judgment equipment) improves (precision improves and throughput increases). Thus, said pretreatment selector 21 mainly consists of a fan 22 for wind selections, an oscillating screen conveyor 23, and a pulse air jet hole 24. In addition, the above-mentioned conveyors 26a and 26b are arranged concurrent at the blowdown side of the pulse air jet hole 24, and commit a transport device.

[0011] Next, the near-infrared type identification unit 29 and judgment equipment 30 are explained using drawing 2 . The near-infrared type identification unit 29 consists of spectroscopes 33, such as a filter arranged between the photo detector 32 which consists of PbS and InGaAs which detect the transmitted light or the reflected light of exposure light from said plastic waste from this light source 31 as the halogen tungsten lamp (light source) 31 which carries out outgoing radiation of the near infrared ray, and said light source 31 and a photo detector 32. Here, after aligning light things, such as a heavy thing of bottles and a tray, vinyl, and a film, on a band conveyor 34 among plastic wastes, the quality of the material was identified by absorption of the near infrared ray of specific wavelength. An amplifying circuit 35, a personal computer 36, and a pneumatic electro converter 37 are electrically connected to said photo detector 32 one by one, and the solenoid valve 39 formed in the header 38 is connected to said pneumatic electro converter 37.

[0012] Said judgment equipment 30 has the judgment box 40 with the rooms 40a-40d divided into plurality. The plastic waste identified according to the quality of the material is blown away by each part stores 40a-40d of said judgment box 40 by controlling high-pressure air (for example, 6kg/cm2) by the solenoid valve 39, and making high-pressure air discharge from the pulse air jet hole 41 in the shape of a pulse. room 40a -- a PET bottle -- PE bottle is contained by room 40c and the bottle of others, such as a detergent and mayonnaise, is contained for a PVC bottle by 40d of rooms at room 40b.

[0013] As stated above, the quality-of-the-material identification unit of the plastics concerning the above-mentioned example The pretreatment selector 21 which consisted of the fans 22 for wind selections, the oscillating screen conveyors 23, and pulse air jet hole 24 grades which carry out outline judgment of the plastics, The conveyors 26a and 26b which the pretreated plastics is aligned and are conveyed, The identification unit 29 which has the photo detector 32 which detects the transmitted light or the reflected light of exposure light from said plastics from the light source 31 which irradiates a near infrared ray at said plastics, and this light source 31, It has composition with the judgment equipment 30 which has the judgment box 40 which carries out the judgment receipt of various kinds of plastics identified by this identification unit 29 with the high-pressure air from the pulse air jet hole 41.

[0014] The operation of the quality-of-the-material identification unit of the plastics of the above-mentioned configuration is as follows. Although it is necessary to align a plastic waste without lapping at a time on [one] a band conveyor when identifying the quality of the material using a near-infrared type identification unit, it is very difficult to make it align. However, in the quality-of-the-material identification unit of this application, the precision of the near-infrared type identification unit 29 of back wash improves in the pretreatment selector 21 by classifying cap 28 grade among plastic wastes, or pretreating bottle 25 and tray 27 kind mechanically.

[0015] Specifically, ten caps (small thing) were dropped from the oscillating screen conveyor 23 not more than 30mmx30mm among 100 plastic wastes. Next, 50 heavy things (30 PET bottles and other 20 bottles) were dropped on nearby conveyor 26a using the fan 22 for wind selections, and the pulse air jet hole 24, and dropped 40 light things (20 trays, ten vinyl, ten films, etc.) on long distance conveyor 26b using the fan 22 for wind selections, and the pulse air jet hole 24. Consequently, the waste plastics collected from conveyor 26a were 100% bottles. Thus, since there are few light waste plastics not more than 30mmx30mm (for example, cap 28) quantitatively, the engine performance of a whole system (pretreatment, discernment, and judgment equipment) improves by making it fall from an oscillating screen and excepting (precision improves and throughput increases).

[0016] Moreover, in said near-infrared type identification unit 29, a near infrared ray is irradiated according to said light source 31 at a sample in the bottles which aligned, a spectroscope 33 receives the amount of light transmission of wavelength peculiar to a sample in a photo detector 32 after that, an absorbance is calculated for each wavelength for every sample by the following formula (1), and the quality of the material is identified.

[0017]

A=log (T1 / T2) -- (1)

Here, it is T1. : The amount T2 of transmitted lights of Ayr in case there is no sample : The amount A of transmitted lights in case there is a sample: In an absorbance and time, infrared light is 16-micrometer light from the wavelength of 2.5 micrometers, and when infrared radiation is irradiated now at this and the infrared period of vibration and the period of vibration of a certain atom are not in agreement, penetrate infrared radiation as it is without affecting the molecule of plastics. However, since each atom or atomic group absorbs the energy according to each period and vibration changes from a ground state to an excitation state when a period is in agreement, it becomes absorption of an infrared spectrum and appears in the place of the wavelength hit on an idea of to the period of vibration.

[0018] However, when moisture will have adhered to the plastics after washing in order that precision may decrease rapidly if water has adhered to plastics as shown in Japanese Patent Application No. 5-5042, it is common to weaken the absorbance of water and to ** precision by using the light called near infrared ray with wavelength shorter (0.8-2.5 micrometers and vibration frequency are high) than infrared light. However, as shown in drawing 3 , the peak of absorption appears in the appearance which laps with 1748nm from 1662nm, and the high accuracy of measurement and an advanced algorithm are required. as advanced distinction and an algorithm, this invention judges the quality of the material synthetically using the ratio of the number of absorption peaks, and the height of each absorption peak rather than is judged only on the wavelength of an absorption peak.

[0019] Next, with the identified signal, control the high-pressure air (6 kg/cm2) of back wash by the solenoid valve 39, high-pressure air is made to blow off by the pulse air jet hole 41 in the shape of a pulse, and a sample is **ed and divided into each part stores 40a-40b of the judgment box 40. although it tested with 100 sum total samples and being tested in ten each of PET, PVC, and PE about each part indoor quality of the material, it was divided in 100% of precision.

[0020]

[Example]

(Example 1) This example 1 is an example using the photo detector which consists of PbS (plumbous sulfide). In order to judge five kinds of quality of the materials, PP (No.1), PE (No.2), PVC (No.3), PS (No.4), and PET (No.5), about five samples of No.1-5, the near infrared was irradiated by 45 incident angles at the sample, and the reflected light was received by the above-mentioned photo detector 32 by 50 angle of reflection. The absorbance A was calculated by following the (2) type based on the quantity of light R (the amount of mirror reflected lights) when total reflection is carried out by the mirror from the quantity of light R (the amount of sample reflected lights).

[0021]

A=logR(amount of mirror reflected lights)-logR (the amount of sample reflected lights) -- (2)

Next, in order to ask for absorption peak wavelength, absorbance A' (with no unit) was calculated by following the (3) type.

[0022]

A'=(A-Amin)/(Amax-Amin) -- (3) However, Amax : Peak Amin of the absorbance of one within the limits : ****** of the absorbance of one within the limits -- the result is shown in drawing 3 . It is PE of No.2, PS of No.4, and PET of No.5 like that the number of absorption peaks is [thing] one in the range of 1600 to 1800nm for being shown in drawing 3 , and the peak is 1732nm, 1682nm, and 1662nm, respectively. Moreover, two absorption peaks are PP of No.1, and PVC of No.3, and in PP, it appears in 1710nm and 1730nm, and, in the case of PVC, appears in 1716nm and 1748nm. Therefore, the quality of the material of five kinds of plastics from the number and peak wavelength of the above-mentioned peak to No.1-No.5 has been judged 100%.

[0023] (Example 2) This example 2 is an example using the photo detector which consists of InGaAs (indium gallium arsenide). The near infrared was perpendicularly irradiated at the sample about five kinds of same quality of the materials of No.1-No.5 as an example 1, and the transmitted light was received by the above-mentioned photo detector 32. The absorbance A was calculated by following the (4) type from the quantity of light T (sample) based on the amount T of transmitted lights of Ayr (reference).

[0024]

A=logT(reference)-logT (sample) -- (4)

Next, in order to ask for absorption peak wavelength, absorbance A' was calculated from the above-mentioned (3) formula. The result is shown in drawing 4 . From drawing 4 , when the absorbance A was changed [3 / No.] into absorbance A' about the range of 1641 to 1763nm, and 1726nm changed the absorbance A into absorbance A' about the range of 1735 to 1763nm, it has judged that 0.0 and a difference (1745 morenm and 1754nm) became [1.0 or 1763nm] 0.05 or less, and 1735nm was the quality of the material of PVC. [1.0 and]

[0025] About No.1, when the absorbance A was changed into absorbance A' about the range from 1641nm to 1763nm, absorbance [of 1716nm, 1726nm, and 1735nm] A' became 0.88 or more values, and it has judged that it was the quality of the material of PP.

[0026] About No.2, when the absorbance A was changed into absorbance A' about the range of 1641 to 1763nm, 1735nm was set to 1.0 and it has judged that it was the quality of the material of PE.

[0027] About No.4, when the absorbance A was similarly changed into absorbance A' about the range of 1641 to 1763nm, 1688nm was set to 1.0 and it has judged that it was the quality of the material of PS.

[0028] When it changed about No.5 and the absorbance A was similarly changed into absorbance A' about the range of 1641 to 1763nm at the end, 1669nm was set to 1.0 and it has judged that it was the quality of the material of PET.

[0029] In addition, the numeric value of measurement wavelength serves as nine to 10 jump because it irradiated the near infrared ray for every wavelength of 9.4nm unit, and it is based on rounding off of the 1st place of a decimal. Thus, according to the above-mentioned example, there is the following effectiveness by judging the quality of the material of a plastic waste from the height of the wavelength of the absorption peak in the absorbance spectrum of this invention, a number, and its peak.

[0030] (1) Polyethylene (specific gravity 0.93) and polypropylene (specific gravity 0.90) do not almost have the difference of specific gravity, and are inseparable in the hydrocyclone classified using a specific gravity difference. However, in this invention, one peak can identify by using claim 1 of a claim by two absorption peaks in which the absorption peak of polyethylene appears in 1735nm from 1710nm, and the absorption peak of polypropylene appears in 1735nm from 1710 to 1726nm, and 1726nm. After discernment can blow away and classify the ingredient which put on the conveyor with high-pressure air etc.

[0031] (2) There are few specific gravity differences also about a PVC bottle (specific gravity 1.17 - 1.25 elasticity) and a PET bottle (specific gravity 1.38), and it is difficult for a specific gravity difference to classify PVC and PET. However, in this invention, it is discriminable like the above (1).

[0032]

[Effect of the Invention] According to [as explained in full detail above] this invention,

they are small things, such as a cap of i bottles, and ii as pretreatment of an identification unit. The precision and throughput of an identification unit of back wash improve by making it very much three kinds of heavy thing **s, such as light things, such as a tray, vinyl, and fill, and iii bottles, an exception. Moreover, the precision and throughput of an identification unit improve by aligning for every piece without starting the very similar sample on a conveyor and lapping a sample.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The explanatory view of the pretreatment selector which is one configuration of the quality-of-the-material identification unit of the plastics concerning one example of this invention.

[Drawing 2] The explanatory view of the near-infrared type identification unit which is one configuration of the quality-of-the-material identification unit of the plastics concerning one example of this invention, and judgment equipment.

[Drawing 3] The property Fig. showing the relation between the absorbance (reflective type) of plastics, and wavelength.

[Drawing 4] The property Fig. showing the relation between the absorbance (transparency type) of plastics, and wavelength.

[Drawing 5] The explanatory view of the distinction approach of the conventional waste plastic.

[Description of Notations]

21 -- Pretreatment selector 22 [-- A pulse air jet hole, 29 / -- Near-infrared type identification unit / 30 / 32 / 34 / 36 / 38 / 40 -- A judgment box 41 -- Pulse air jet hole. / -- A header, 39 -- Solenoid valve / -- A personal computer, 37 -- Pneumatic electro converter / -- A conveyor belt, 35 -- Amplifying circuit / -- A photo detector, 33 -- Spectroscope / -- Judgment equipment, 31 -- Light source] -- The fan for wind selections, 23 -- An oscillating screen conveyor, 24